Investigation of Diesel Spray Penetration, Vaporization, and Combustion in a Pilot-Ignited Natural Gas Engine, 03-9074

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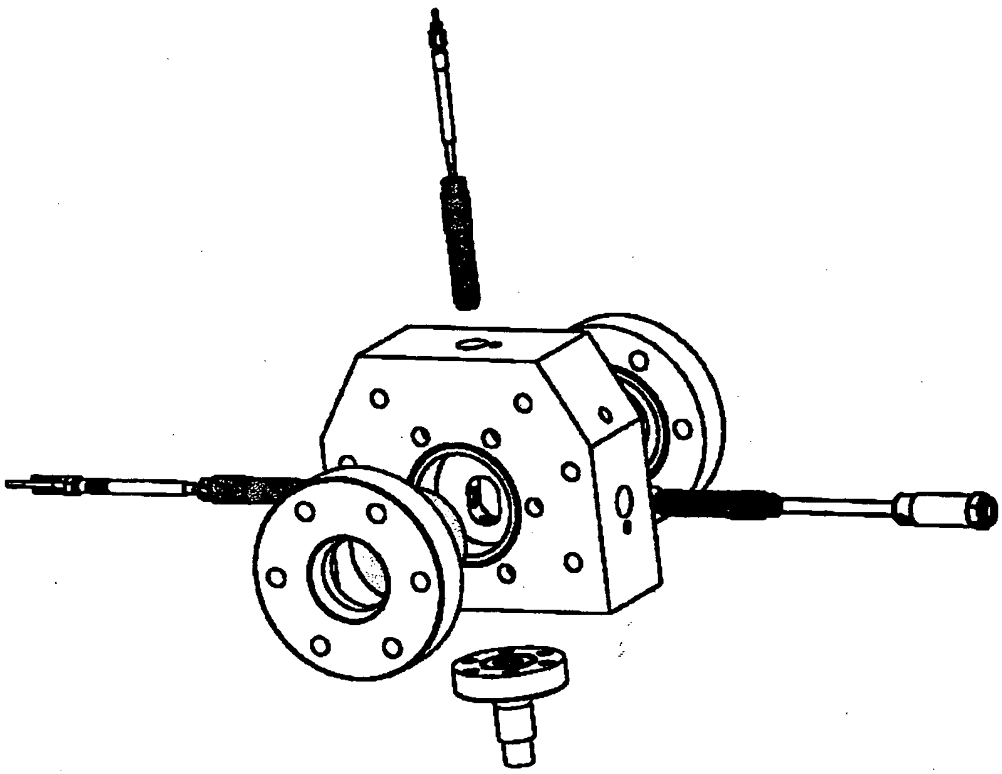
Background - Future stationary natural gas engines in the one- to two-megawatt power range are expected to achieve an efficiency of 50 percent and a NO_x emissions level of five parts per million. Achieving these goals requires that new technology be developed during the next four to six years. A promising technology for natural gas engines is micropilot prechamber combustion (MPPC). MPPC uses a diesel pilot to ignite a prechamber which, in turn, ignites the natural gas-air mixture in the main combustion chamber. Using this concept permits the ignition of lean air/fuel mixtures required for low emissions and high efficiency. The small pilot quantities and high air velocities in the prechamber create an environment unlike conventional direct-injection diesel engines. However, SwRI must understand the fundamental fuel/air interaction to optimize this combustion system for high efficiency and low emissions.

Approach - High-speed cinematography using the Schlieren technique will be applied to visualize the diesel pilot fuel spray penetration, vaporization, and mixing in an optically accessible prechamber representative of a typical pilot-ignited natural gas engine. A test matrix will be designed to examine the effects of the injection nozzle hole size, fuel jet orientation relative to the air velocity field, and prechamber temperature and pressure. The movies of the injection events will be analyzed for jet penetration and density gradient representing fuel/air mixing. The experimental tests will be simulated using multidimensional modeling. The movies will then be used to validate the computational models by comparing jet penetration data and density gradient fields.

Accomplishments - The optically accessible prechamber and pilot injection system have been designed, procured, and fabricated, and the prechamber has been designed to permit testing with the pilot injector located on either side or the top. The prechamber, quartz windows, window clamps, fuel injector, glow plug, and pressure transducer are shown in the illustration. The prechamber is connected to a pneumatically controlled valve, which controls

the admission of heated and pressurized air from a main chamber pressure vessel to simulate the filling that occurs in the engine. An electronic controller is being developed to time the air admission, fuel injection, and imaging equipment. Testing will begin after completion of the test setup, followed by computational modeling and comparison of the results.



The SwRI-designed prechamber and pilot injection system permits testing with the pilot injector located in three different positions.

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D6278-02 Standard Test Method for Shear Stability of Polymer Containing Fluids European Diesel Injector Apparatus

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1. Scope

1.1 This test method covers the evaluation of the shear stability of polymer-contain The test method measures the percent viscosity loss at 100°C of polymer-containin when evaluated by a diesel injector apparatus procedure that uses European diesel test equipment. The viscosity loss reflects polymer degradation due to shear at the

Note 1-Test Method D 2603 has been used for similar evaluation of shear stability; l are as indicated in the significance statement. No detailed attempt has been undert correlate the results of this test method with those of the sonic shear test method.

Note 2-This test method uses test apparatus as defined in CEC L-14-A-93. This test differs from CEC-L-14-A-93 in the period of time required for calibration.

Note 3-Test Method D5275 also shears oils in a diesel injector apparatus but may gi results.

Note 4-This test method has different calibration and operational requirements than Method D 3945.

1.2 This standard does not purport to address all of the safety concerns, if any, ass its use. It is the responsibility of the user of this standard to establish appropriate s health practices and determine the applicability of regulatory limitations prior to use precautionary statements are given in Section 8.

2. Referenced Documents

D445 Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and t Calculation of Dynamic Viscosity)
D2603 Test Method for Sonic Shear Stability of Polymer-Containing Oils
D5275 Test Method for Fuel Injector Shear Stability Test (FISST) for Polymer Conta FluidsCoordination European Council (CEC) Standard:
D3945 Test Method for Shear Stability of Polymer-Containing Fluids Using a Diesel I Nozzle
CEC L-14-A-93 Evaluation of the Mechanical Shear Stability of Lubricating Oils Cont Polymers